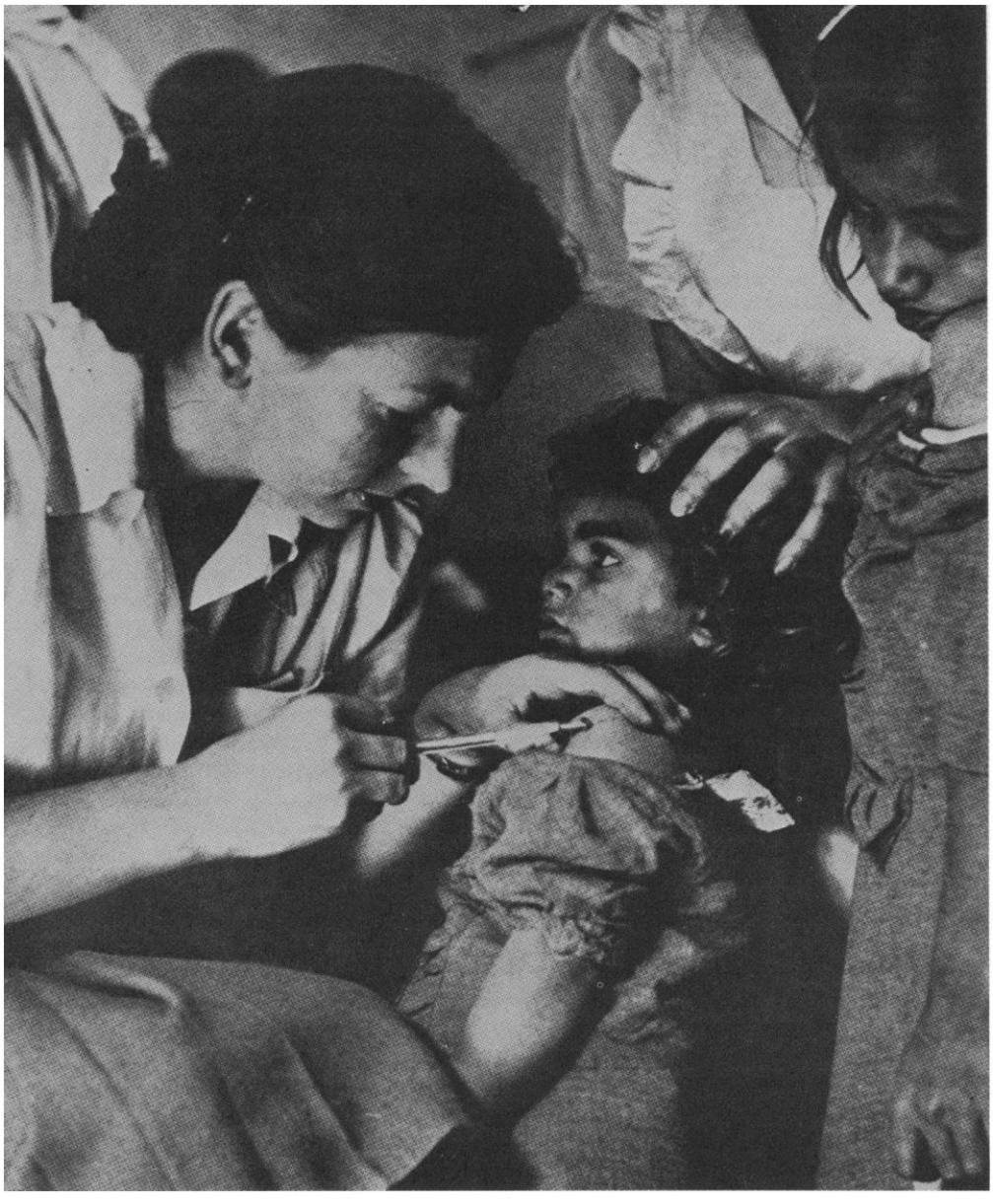

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Studies of Human Ecology in Relation to Health and Behavior

The general behavior of men, and that special form of organismic behavior that we call "illness," are most often studied in the laboratory, because it is thus possible to limit or control the variables that enter into the experiment under observation; but they can be fully understood only in terms of the context in which they naturally occur — as manifestations of the complex, highly ordered, multivariate systems made up of people interacting with their environment. The branch of biology that deals with interactions between organisms and their environment is "ecology." The branch of human biology that deals with the interactions between men and their environment is "human ecology." The relation of infectious, parasitic, and dietary diseases to human ecology has been a concern of medicine for many years. During recent years this concern has been extended to the study of the relation of human ecology to health in general, and especially to the disturbances of mood, thought, and behavior, the disorders of adaptation, and the chronic degenerative diseases, all of which have been shown to be markedly influenced by the interaction between men and the environment in which they live.

Because man is a social animal who accumulates an extensive culture and lives in complex societies, a very significant proportion of the human environment is made up of the people who surround a man, and the society of which he is a member . His interaction with these "social" and "personal" aspects of his environment is fundamentally communicative in nature. Information from this part of his environment, obtained through his sense organs

and evaluated in his central nervous system, leads him to display patterns of gross behavior or of organ function which may significantly influence the course of his disease, or the circumstances of its occurrence. The study of human illness in its natural context, therefore, requires that one consider the "social" and "personal" environment, the behavior of the man, and the communicative interchanges between the man and the world around him, as well as the so-called "physical" environment and such quantitative energy interchanges as those that involve food and water intake, muscular activity, and the like.

In point of fact, the "social" and "personal" aspects of the environment need not be separated from the "physical" environment and can be regarded simply as special aspects of it. In other words, the physical manifestations of a society — the people, the buildings, the machines, and other artifacts that the society produces — constitute a large proportion of the material world in which men live; beyond this, a "society," from the point of view of the individual man, may be looked upon as a set of directions for behavior, for communication, for interrelation with other people, and for evaluating the behavior of other people and the meaning of events and situations. These "rules," which are largely implicit, may be called "rules" only because of their generality and relative consistency. They are shared in large measure by people who share the same culture and, in effect, they are the "culture." They are learned systematically throughout the period of growth and development and, to a certain extent, throughout life. They form the basis on which the individual evaluates much of the information that he receives from the world around him and the people in it. As for the "personal" aspect of the environment, this is made up of those with whom the individual has had special and, to a certain extent, idiosyncratic experiences — parents, relatives, or other close associates of various sorts. Because of the special quality of his experience with these people, or of his relation to them, these people may evoke special, and sometimes intense and conflicting, responses in him.

It is worthy of note, at this point, that the physical process by which a word, a gesture, or an "event" is recognized and evaluated by a man is fundamentally the same as that by which a foreign protein or bacterium is recognized and evaluated, even though the two processes may take place in different cells, and involve different organ systems, and even though one may be a good deal more complex than the other. In both instances the response of the human organism is a complex pattern of behavior which appears to be biologically meaningful, in the sense that it is nonrandom and is generally directed toward preserving the integrity of the human organism or of the man's relation to the society in which he lives and to the people around him. In both instances the response may involve both the behavior of the person as a whole and internal adaptive reactions that involve the functions of his various organ systems, all the way down to the cellular and enzymatic level.

A system such as this may be studied at any one of several levels, depending upon the interest of the investigator and the problem before him. In the past, the study of the relationship between *groups* of men and their environment has encompassed the major part of what has been regarded as classical "human ecology." J. W. Bews has termed this "synecology" (1). That portion of human synecology which is concerned with the spatial distribution of human populations in relation to certain physical and social features of their environment has been rather intensively studied by sociologists and demographers such as Parks, Hawley, and Quinn, while the other areas of human syneocology have been relatively neglected. This has been true to such an extent that some have come to believe that the spatial distribution of human populations represents the total content of human ecology. But more recently, human biologists have begun to consider the more general biologic aspects of the relation between groups of men and their environment, and are adding a new dimension to human ecology along the lines that Bews so long advocated. At the same time, the considerations of epidemiology have expanded far beyond its former concern with bacterial agents, insect and animal vectors, food supply, and water pollution, to include not only the study of such factors as air pollution, noise level, and population density in relation to disease but also the study of the influence of patterns of human behavior such as cigarette smoking and compulsive striving, and the influence of social processes such as culture change or occupational mobility. In this manner the whole content of synecology is being woven into the study of human health. If we view a man as an open-ended system, constantly interacting with his environment in order to maintain his life and his functions as a member of the species, it seems inevitable that this must be the case.

The branch of human ecology which deals with the interrelations between the *individual* man and his environment — what Bews termed "autecology" — was almost neglected by human ecologists in the past; but it has become an increasingly important concern of the physiologist and the physician. While disease does often manifest itself in the form of the epidemic or endemic phenomena that are features of the behavior of human populations, it is most frequently manifested as a feature of the biologic behavior of the individual man. Since a great deal of the concern of medicine is with the health, the longevity, and the effective functioning of the individual, it is not surprising that a good deal of the impetus for the study of autecology has arisen within schools of medicine. The study of autecology in relation to illness has been an important, though by no means a sole, consideration of the Division of Human Ecology at Cornell University Medical College.

As with any other branch of science, one studies special problems in the field of human ecology in relation to specific aspects of disease and does not attempt to encompass the whole field at one fell swoop. Because the science has been relatively new, the concepts untried, and the methods undeveloped, our initial steps over the past 10 years have been halting, and we have found the path more difficult than we had at first supposed. Under the impetus of the investigations of H. G. Wolff, and with his stimulation and guidance, members of the staff of the Division first concerned themselves with the nature of the bodily reactions of men to events and situations arising in their "personal" or "social" environment. An example of this was the study of diabetes mellitus (2).

The diabetic human, possessing a defect of energy metabolism which is probably genetically determined, manifests this by a relative inability to metabolize glucose, by the appearance of glucose in his urine, by the passage of a large vol-

ume of urine, and by a relatively high level of fat metabolism. Much of the time he has a high level of various forms of fat in his blood — not only of whole fat but of cholesterol and lipoprotein, as well as products of fat breakdown that commonly are referred to as "ketone bodies." Under certain circumstances, the diabetic may develop an acute metabolic decompensation, which can be fatal if it is not halted. When this occurs, the volume of his urine increases greatly and the amount of glucose that he excretes may increase very greatly. He loses large volumes of body fluids and becomes dehydrated. At the same time, the concentration of ketone bodies in his blood may rise to very high levels. As a consequence of all this, his internal economy may be severely deranged. The sodium content of his blood decreases, the potassium content increases, the pH shifts toward the acidic range, his blood volume falls, and his blood viscosity goes up. Ultimately, his circulation is impaired, and the metabolism of his brain becomes deranged. If his condition is not treated, he may lapse into coma and die.

The study of these acute decompensations of diabetes by many investigators revealed that they do not occur as simply random and unexplainable events. They take place during acute intercurrent illnesses of various sorts, and especially during infectious illnesses associated with fever. They occur after acute injuries, and they occur during metabolic disturbances such as those produced by hyperthyroidism. They also occur in association with disturbances of interpersonal relations — events which are commonly (but by no means always) manifested by "emotional up-sets." Recent studies have indicated that "emotional upsets" are probably the most common single event associated with diabetic acidosis in children and in those with the labile form of the disease (3).

The investigation of these "emotional upsets" revealed that most of them were, in turn, precipitated by acute conflicts with parents, relatives, or other close associates. At first it seemed that the mechanism of the diabetic decompensation might be simple — the patient might merely cease to take his insulin and to follow his prescribed diet; but further investigation showed this was not the case. It was found that the presentation of the proper verbal or situational stimulus to the patient could lead to prompt development of ketonemia and diuresis, even if his medication and activity were quite unchanged. Furthermore, a similar procedure could produce a similar reaction, though of a lesser magnitude, in people with no evidence of diabetes. As the evidence accumulated, it became apparent that the human, having limited stores of carbohydrate, responds to starvation, and to any situation that creates an increased demand for energy — profound muscular exercise, fever, infection, or tissue damage — with a relative increase in fat metabolism. This reaction, which seems to be mediated primarily through the anterior pituitary, appears to be "protective" and "biologically meaningful" in that it has the effect of preserving the integrity of the organism in the face of a threat to its energy supply and its blood glucose level. It can be initiated by the central nervous system in response to information evaluated as threatening. Thus, the diabetic person with a labile metabolism and a precarious carbohydrate homeostasis may find himself precipitated into grave metabolic difficulties by his own metabolic adaptive reactions, which are, under other circumstances, beneficial; and these reactions may be set off not only by injury or illness but by changes in his relations to the people around him.

The investigation of this metabolic reaction pattern and its influence upon diabetes required the techniques of the biochemist, the physiologist, and the experimental psychologist. As our studies of human ecology have proceeded, the assistance of an even wider range of scientific disciplines has been required. For example, earlier studies of Holmes and others had shown that nasal mucosa responds to a variety of noxious or threatening stimuli with a reaction of engorgement and increased secretion (4). This reaction also can be initiated by higher centers of the nervous system, and often accompanies weeping or feelings of sadness. An effort to study the effect of such reactions upon the occurrence of acute respiratory illnesses was carried out by obtaining a carefully designated sample of 24 women drawn from a group of more than a thousand who worked in two large rooms in an office building in New York City (5). These women were followed over the course of a winter, with observation of their general health, their nasal symptoms, the color and secretion of their nasal mucosa, their clinical evidences of respiratory illness, viral and bacterial cultures of their noses and throats, and observations of their social background, their daily round of life, and their general mood and behavior. This effort required the collaboration of physicians, epidemiologists, virologists, bacteriologists, sociologists, and clinical psychologists. It produced evidence that the nasal reaction which is referred to as a "common cold" occurred among these women most frequently, and in its most florid form, at times when their nasal mucosae were already engorged and secreting for other reasons. In the winter, differences in the temperature of ambient air, between indoors and outdoors, appeared to be an important reason for this; but, a more important reason appeared to be changes in the mood and the pattern of activity of the woman, in response to changing relationships to the people around her and the events that she encountered. Apparently viral infection of the nasal mucosa of a woman sad, tearful, and fatigued often produced florid illness; while infection of another woman, well-rested and not aroused, produced little or no illness.

In our ecological investigations we have proceeded on the assumption that the variable that one undertakes to investigate may be any one of several kinds; that the sample of people upon whom the investigation is carried out may be any that best helps the investigator to answer the questions that he has raised; that the work may be done in the laboratory or the field, whichever is most appropriate; and that the methods that are used are likely to require the collaboration of scientists from a number of disciplines. Whatever is unique about ecological investigations seems to lie in their focus of interest — they are concerned with the better understanding of some portion of the biological system that is made up of men living in their natural context and interacting with it. In our own case, as physicians, we have concerned ourselves primarily with how this interaction affects health; but others may have a much different interest.

For example, in some of our earlier studies we became interested in how illness is distributed among people of similar characteristics who have lived under the same environmental circumstances for a long period of time. For the purposes of these studies we selected career workers in a large industry who had

highly specifiable characteristics and who had lived under highly specifiable circumstances during their adult lives. This led to the observation — later confirmed in several other groups — that disability, impairment of longevity, and the symptomatic manifestations of illness are not evenly distributed among the members of such groups (6). If one assumes an equal risk of illness among members of such a group, then some members have far more, and others far less, than their expected share of illness. An interesting sidelight to this finding was the observation that those members of the group who had the smallest amount of illness ("the healthiest") were not necessarily the most highly valued or productive members of the group (7). This led to a subsequent investigation of the effect of culture change and social dislocation on health — using a group of displaced Chinese (8). The findings of this study indicated that some people who were able to survive a profound disruption of their social milieu and personal ties over an extended period of time with little evidence of ill health may display a shallowness of interpersonal relations, a loose attachment to goals, and a lack of concern for means, which, in a different context, might be considered to be indicative of a psychopathic personality trait.

In these two studies the clinical psychologist, the anthropologist, and the sociologist contributed heavily. In other investigations carried out in the laboratory, other areas of science have been called upon for assistance. For example, the diuretic phenomenon, first encountered in the study of diabetic decompensations, was further investigated with the use of human volunteers who showed no evidence of diabetes or any other metabolic defect (9). It was found that a water diuresis is rather readily produced in aroused or alerted people, who often feel "anxious" or "apprehensive" at such times. Furthermore, such a diuretic reaction can be "conditioned" without great difficulty by the use of a modification of the classical Pavlovian technique. Here, and in studies of gastric motility, of appetite and food intake, of arousal and fat metabolism and in similar areas, the collaboration of the physician, the biochemist, the mathematician, and the experimental psychologist have been necessary. The field of special assistance undoubtedly will widen as a larger number of investigations are pursued. At one end of the spectrum, the development of techniques and devices for monitoring and telemetering such bodily functions as gastric motility and electrical phenomena of cardiac contraction now find us calling upon the assistance of the elecronic engineer and the physicist(10); at the end, the study of the effects of interrogation and indoctrination upon prisoners-of-war (so-called "brainwashing") has found us calling upon the historian and the political scientist to help us understand the context in which certain events have occurred(11).

There is, of course, no advantage simply to having a number of scientists from several disciplines working together on the same problem, if a single person could accomplish as much; but, such is the complexity of the biologic system in which men live, and such the diversity and sophistication of the scientific tools necessary to study even a portion of it, that it has become increasingly unlikely that any one man can investigate a problem in this area in both the breadth and the depth that are required for a true description of the events that occur. One man or a few may frame the hypothesis and design the experiment, and someone, probably one man, must see that the work proceeds constantly toward the end in view, and that the group works in harmony and to completion; but a common understanding of the purpose of the work and a free intercommunication among all those engaged in the common enterprise is essential. The ultimate product is usually a body of information meaningful from several points of view, and expressed in terms of the conditional interaction of a number of variables. It often bears a discernible relation to the purely anecdotal description of men's reactions to their affairs that we are accustomed to reading in nonscientific literature; but it is more exact and sometimes contains some unusual and rewarding surprises.

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